

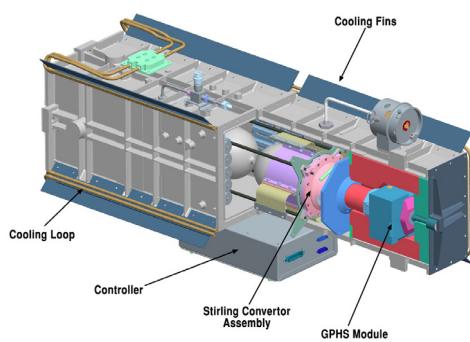


Radioisotope Power Systems

The U.S. Department of Energy (DOE) and its predecessor agencies have been producing radioisotope power systems (RPSs) for over 40 years. A RPS is a unique technology used in applications that require a long-term, unattended source of electrical power and/or heat in harsh and remote environments. These systems are reliable, maintenance free, and capable of producing electricity or heat for decades. The unique characteristics of these systems make them especially suited for applications where the use of solar power or batteries is not practical.

For the past four decades, DOE has supplied the National Aeronautics and Space Administration (NASA) missions with RPSs, including plutonium-238-fueled radioisotope thermoelectric generators (RTGs) and radioisotope heater units (RHUs), as the source of electric power and heat for space missions. RPSs have been used safely and reliably on 25 missions and the recent Cassini-Huygens mission to Saturn. DOE's role in space missions reflects an established ongoing cooperation between DOE and NASA that ensures the RPS production capabilities are maintained and coordinated to meet NASA mission requirements.

Plutonium-238 is also needed for RPSs for national security missions, increasingly so after the events of September 11, 2001. Because the national security applications are classified, the need for plutonium-238 can only be characterized by how it is not used: It is not used in any nuclear or nonnuclear weapons, military satellites, in space, or in any missile defense system.

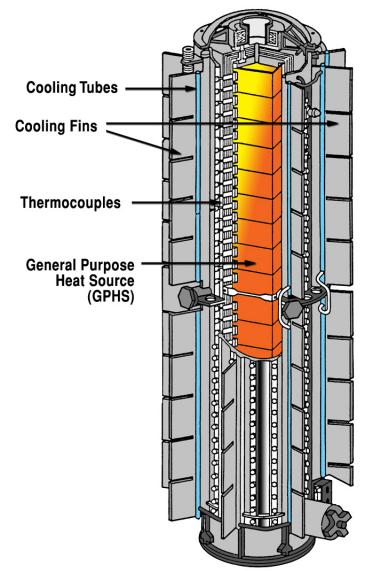


Stirling Radioisotope Generator (SRG)

What is an RPS?

A RPS is a lightweight power system that consists of two major components, a heat source and a power conversion system. There are currently two types of conversion systems used in RPSs. RTGs work by converting heat generated by the radioactive decay of plutonium-238 (a non-weapons grade isotope of plutonium) to electricity using thermocouples. RTGs are static systems with no moving parts and are very reliable.

The other radioisotope power system is the Stirling radioisotope generators (SRGs). The SRG uses a conversion system that is based on the stirling thermodynamic cycle. SRGs have moving parts, as opposed to RTGs, but have substantially higher efficiency.



Radioisotope Thermoelectric Generator (RTG)

RPSs do not work like nuclear power reactors. Nuclear power reactors use the fission process to generate heat, which is then converted to electricity. An RPS is not a nuclear reactor; it does not use either fission or fusion to produce heat. Chain reactions do not occur inside RPSs; plutonium-238 cannot sustain a chain reaction. As a result, plutonium-238 is not a proliferation risk.

The plutonium dioxide fuel (the heat source) contained in RPSs is a specially formulated fire-resistant ceramic material that is manufactured in pellet form to reduce the possibility of fuel dispersion in the event of a launch or reentry accident. The ceramic form of plutonium-238 dioxide is heat-resistant, and if fractured, tends to break into relatively large particles and chunks.

Radioisotope Power Systems

The material is very stable in the environment. It is highly resistant to dissolving in water and does not react very much with other chemicals. These characteristics help to mitigate potential health effects should an accident occur involving the release of this fuel.

Multiple layers of protective materials protect and contain the fuel and reduce the chance of release of the plutonium dioxide. Iridium, a strong, ductile, corrosion-resistant metal with a very high melting temperature encases each fuel pellet. Impact shells made of lightweight, high-strength, and highly heat-resistant graphite provide additional protection.

The fuel is contained in independent modular units, each module containing four plutonium dioxide pellets. Each module has its own heat shield and impact shell. This design reduces the opportunity for fuel release in the event of an accident.

Why is solar power not practical?

In space, power is a precious commodity. In Earth's orbit, a five-foot-square solar panel will produce about 300 watts of electricity, about the same as one of the RPSs on the Cassini spacecraft. To produce the same amount of power at Jupiter, for example, where the sun's rays are 25 times weaker than they are near Earth, solar panels the size of a football field and weighing 1,200 pounds would be needed to provide the same amount of electricity.

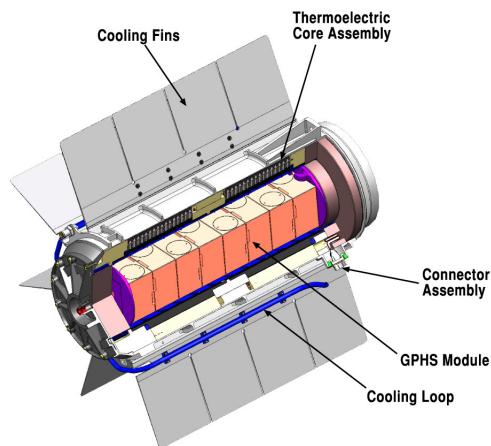
Are more advanced RPSs being developed?

Although essential to space missions, very reliable and long lasting, thermocouples are highly inefficient. Most RTGs have efficiencies of between 5 and 7 percent. This means at least 93 percent of the heat generated by the decay of the plutonium-238 is wasted. More efficient power conversion systems would mean that less radioactive fuel would be needed, which would reduce the cost of the fuel and the weight of the generator. As a result, DOE

and NASA are developing advanced, high-efficiency RPSs such as the SRG.

The SRG and the Multi-Mission Radioisotope Thermoelectric Generator (MMRTG) are being developed to provide spacecraft with electric power for potential use on future NASA missions. These power systems will be designed to operate on planetary bodies as well as in the vacuum of space. The SRG design will build upon a 55-watt-electric Stirling convertor, which uses moving parts to mechanically convert heat to electricity. Each SRG will use two Stirling convertors to deliver 100 to 120 watts of electric power from about 500 watts of thermal power.

The MMRTG, a new generation of power system, will be designed to generate approximately 100 watts of electricity with a more flexible modular design capable of meeting the needs of a wide variety of missions. The MMRTG will use thermo-electric materials that have demonstrated extended



Multi-mission Radioisotope Thermoelectric Generator (MMRTG)

lifetime and performance capabilities, and will be designed to use a heat source composed of eight plutonium-238-containing modules, each of which would provide approximately 250 watts of thermal power.

For information on the EIS for the Proposed Consolidation of Nuclear Operations Related to the Production of Radioisotope Power Systems (Consolidation EIS) contact: Timothy A. Frazier,
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